Historic, Archive Document

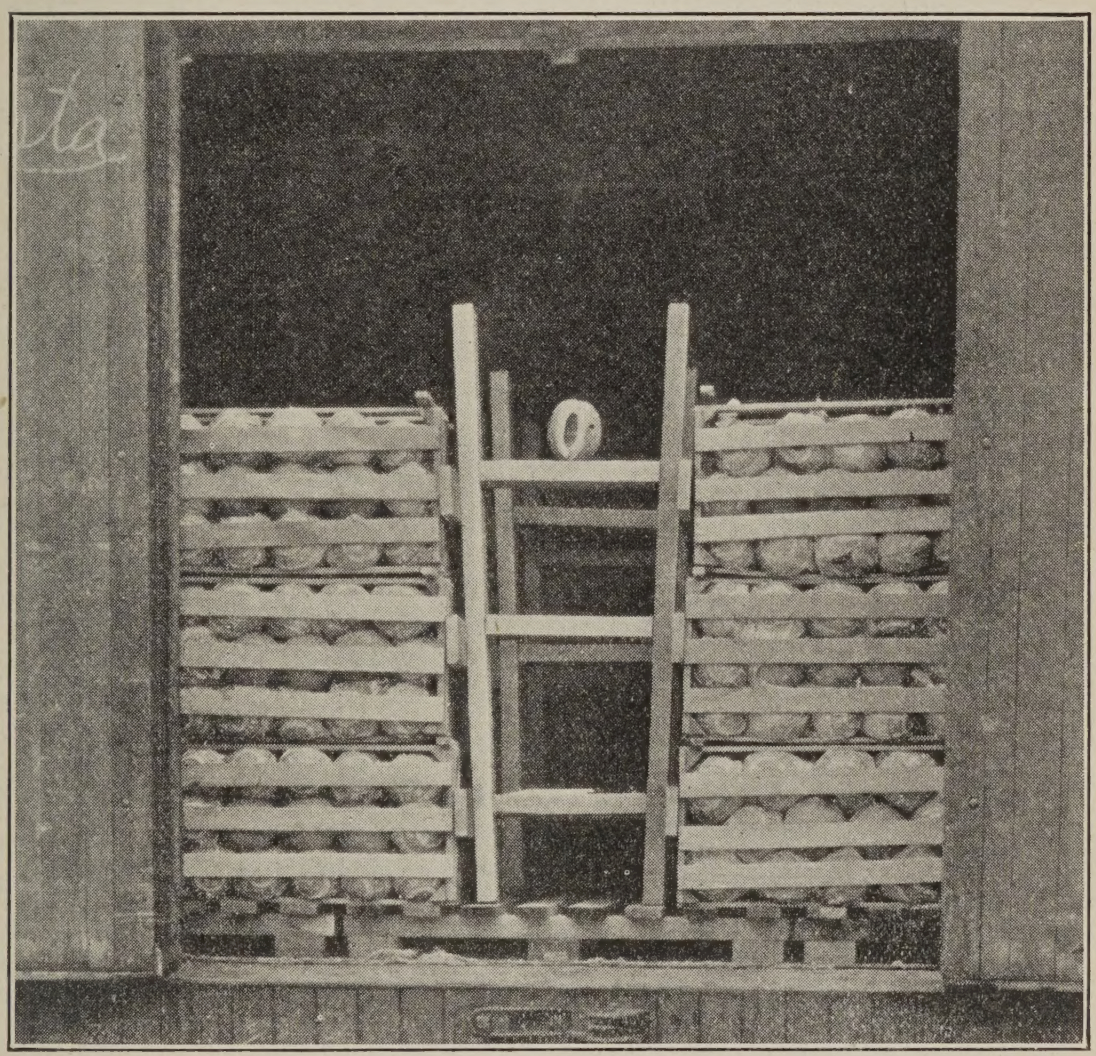
Do not assume content reflects current scientific knowledge, policies, or practices.

LOADING AND TRANSPORTING WESTERN CANTALOUPES

By

A. W. McKAY

Specialist in Marketing



UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF MARKETS

CHARLES J. BRAND, Chief

Markets Doc. 10 Washington, D. C. June, 1918

SUMMARY

LOADING different styles of cantaloupe packages together obstructs air circulation and seriously retards refrigeration.

Cantaloupe shipments loaded seven standard crates wide and three high can be cooled more easily and uniformly than those loaded six crates wide and four high at the bulkhead.

Floor racks are an effective aid in the refrigeration of cantaloupe shipments.

The ability of refrigerator cars to cool cantaloupe shipments quickly and maintain desirable temperatures in transit depends directly upon proper bunker and bulkhead construction and upon the quantity and quality of the insulating material employed in their construction.

Workmanlike construction of refrigerator cars, inspection for defects, and the maintenance of the cars in good repair are essential for satisfactory service.

Salt may be effectively employed to hasten the refrigeration of cantaloupe shipments.

The wrapping of cantaloupes serves to retard the rate of cooling.

Moving cantaloupe cars with the ventilators open during the first night in transit does not appear to affect the refrigeration of the melons, or their condition upon arrival at market.

LOADING AND TRANSPORTING WESTERN CANTALOUPES

CONTENTS

	Page		Page
General considerations	3	Car construction and insulation	10
Effect of mixed loading on refrigeration	5	The use of salt as an aid to refrigeration	12
Temperatures in transit	7	Miscellaneous practices affecting refrigeration	15
Floor racks	7		

GENERAL CONSIDERATIONS

DURING the shipping seasons of 1915, 1916, and 1917, the United States Department of Agriculture conducted investigations to determine the transit temperature conditions under which western cantaloupes are forwarded to market, and the influence of loading methods and modifications of car construction in retarding or accelerating refrigeration. Test trips were made from the Imperial Valley, Cal., Turlock, Cal., and Glendale, Ariz. In each test, the shipments under observation were loaded on the same day and the cars moved in the same train to destination. They were accompanied by representatives of the Department, who at intervals, approximately five or six hours apart, secured a record of the temperature of the air and melons at 12 selected locations in each car. The observers also obtained a record of the atmospheric temperature, and, in most cases, of the actual weight of the ice supplied each car. The number of cars in each test varied from 4 to 13, the usual number being about 8.

The temperatures within the cars were obtained by specially constructed electrical thermometers. These thermometers were connected by short cables to a master cable. A small portion of the master cable, in the form of a flattened plate, passed out between the door and door frame to the roof of the car. Thus no opening was made that would permit an appreciable influx of hot air. The temperature readings were obtained from the roof of the car. By the use of this equipment, it was possible to obtain an accurate record of temperature conditions within the cars without opening the doors or ventilators at any time. It was also possible to obtain the temperature of melons in crates at the bottom of the load, and at other points where it would have been impossible to locate or read mercury thermometers.

Every effort was made to control each shipment tested, so that it differed from the others in the same test only with regard to the

particular factor under investigation. This was accomplished in all cases, so far as it was possible under actual service conditions. The effects of loading methods, car construction, and refrigeration practices on the temperature of cantaloupes in transit are presented graphically in the illustrations accompanying the text.

Although the investigations discussed herein were conducted only with cantaloupes grown in California and Arizona, they should prove of interest to growers and shippers of cantaloupes in other sections of the country. The results presented are directly applicable to the shipment of cantaloupes, wherever grown, which are three days or longer in transit.

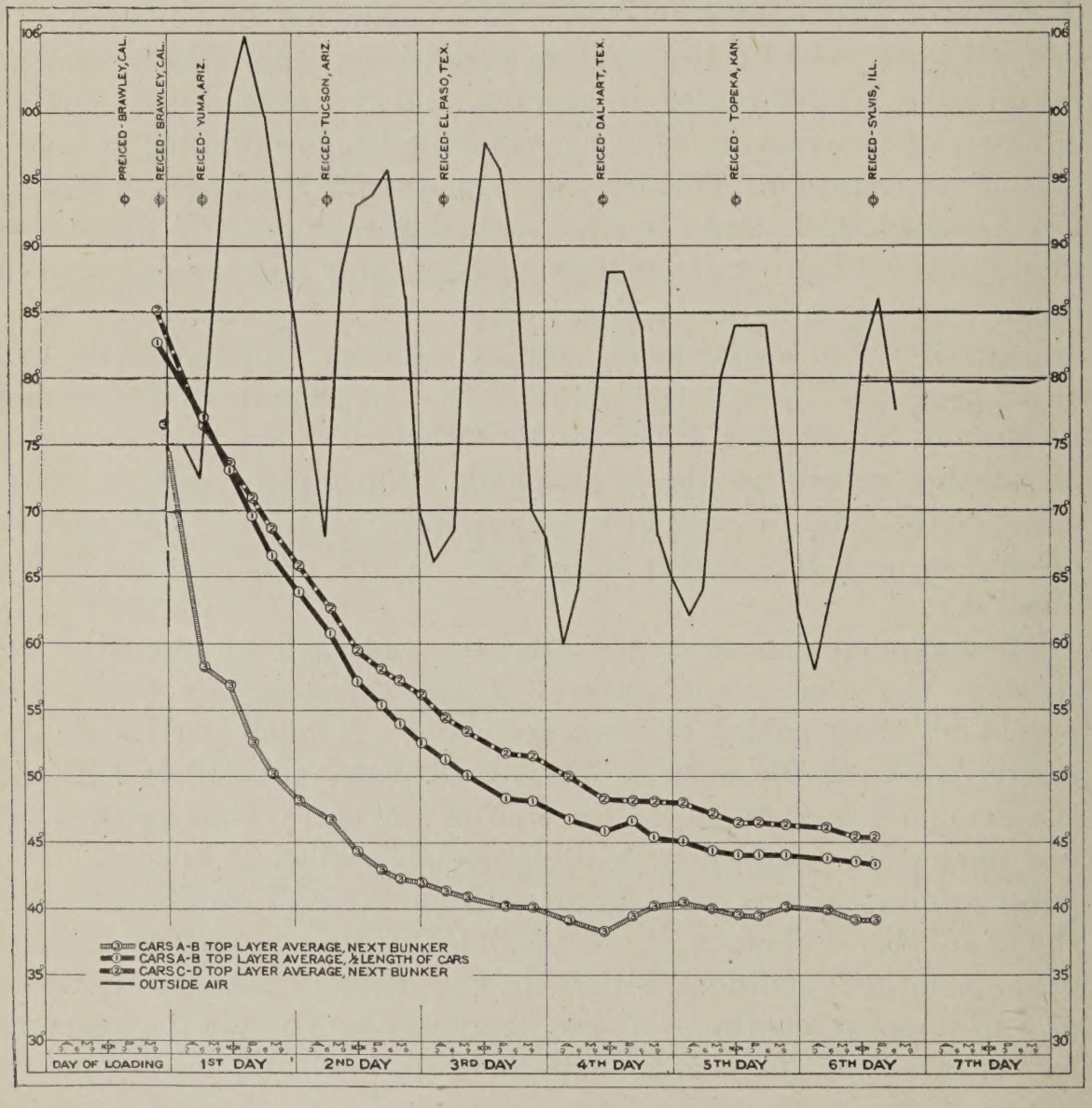


FIG. 1.—Diagram showing top layer temperatures at the bulkhead and adjacent to the bracing in cantaloupe shipments. Each curve represents the average of two cars. Cars A and B were loaded 7 crates wide and 3 crates high throughout; cars C and D were loaded 6 crates wide throughout and 4 crates high in the 4 stacks next to each bulkhead. These cars were in transit from Brawley, Cal., to Chicago, Ill., June 19 to 25, 1916.

EFFECT OF MIXED LOADING ON REFRIGERATION

A factor of great importance in influencing the refrigeration of cantaloupes in transit, and one which is under the direct control of the shipper, is the method of loading employed, and the care taken to secure a uniformly-spaced load. One of the greatest obstacles to rapid and uniform refrigeration is the common practice of mixing different styles of packages in the same load. The circulation of cold air from the ice bunkers through the load by natural means is necessarily slow. If open spaces between the rows of packages are not provided, the flow of cold air toward the center of the car is checked. Under these conditions, the air rises toward the ceiling of the car, and returns to the ice bunker without completing its normal circuit, and consequently refrigeration of the crates in the center of the car is retarded materially.

Though mixed loading is the most common cause of these air blockades, careless loading or shifting of packages will bring about the same unfavorable condition. Every effort should be made to load only one style of package in the same end of a car. If it should be necessary to load flats and standard crates together, the flats should be placed on top layers or in the stacks nearest the bracing.

Figure 1 shows the temperatures secured in four cars of cantaloupes, which were included in a test from Brawley, Cal., in 1916. Two of these cars were loaded 7 crates wide and 3 high throughout. The other two were loaded 6 crates wide and 4 high, for a distance of 4 stacks from each bulkhead. The remainder of the load was 3 crates high.

The temperature records, which have been confirmed by later tests, show that cantaloupes four crates high cannot be cooled satisfactorily in the ordinary refrigerator car. It will be noted that the average temperature of the top layer crates at the bulkhead in cars loaded 6 wide and 4 high is higher than the top layer temperature in the center of the cars loaded 7 wide and 3 high, and considerably higher than the top layer temperature at the bulkhead of these cars. The average temperature at the center of the cars loaded 6 crates wide was lower than the temperatures against the bulkhead, owing to the fact that the melons were only 3 crates high at this point. It corresponded almost exactly with the average top layer temperature at the center of the cars loaded 7 wide, and for that reason has not been included in the diagram.

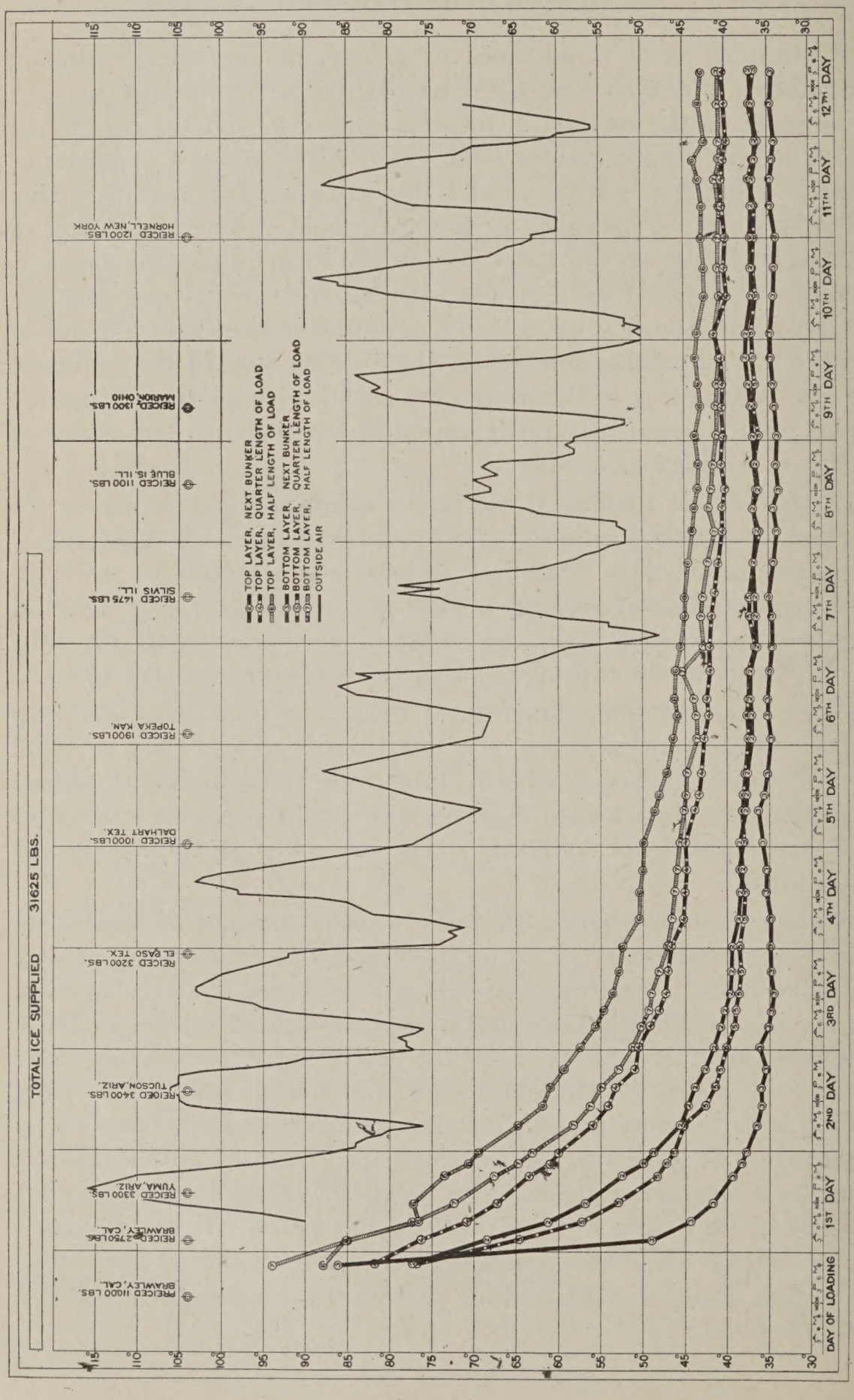


FIG. 2.—Diagram showing cantaloupe temperatures in a car equipped with open bulkheads and not equipped with floor racks. This car was in transit from Brawley, Cal., to New York, N. Y., June 26 to July 8, 1917.

TEMPERATURES IN TRANSIT

Figures 2 to 7 illustrate graphically the temperatures in transit secured in cars of cantaloupes, when the cars vary in construction and in the refrigeration methods employed. The six temperatures shown on each chart are those which are approximately representative of conditions throughout the whole load. They were secured in crates located in the top layer at the bulkhead, the bottom layer at the bulkhead, the top layer half way between the bulkhead and door frame, the bottom layer half way between the bulkhead and door frame, the top layer next to the bracing, and the bottom layer next to the bracing. It will be noted that the temperatures in these six positions vary considerably.

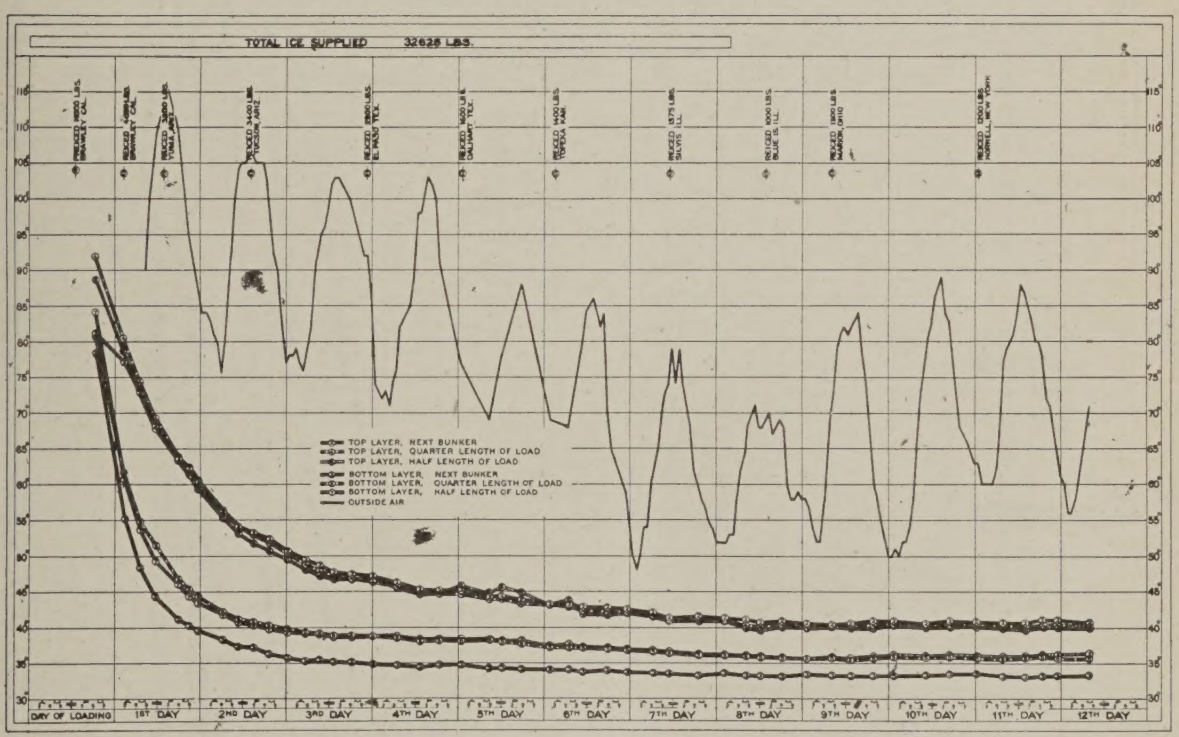


FIG. 3.—Diagram showing cantaloupe temperatures in a car equipped with basket bunkers, insulated bulkheads, and floor racks. This car was in transit from Brawley, Cal., to New York, N. Y., June 26 to July 8, 1917.

FLOOR RACKS

Slatted false floors, or floor racks, have proved to be a most effective aid to refrigeration, and have been included as part of the equipment of nearly all refrigerator cars constructed since 1916. As permanently constructed, the floor racks are hinged to the car walls, and may be raised when the car is cleaned. The cross-slats are approximately 4 inches wide, and are sufficiently close together to permit trucking over the racks. The lengthwise stringers are 4 inches high, providing a clear 4-inch air space under the entire load.

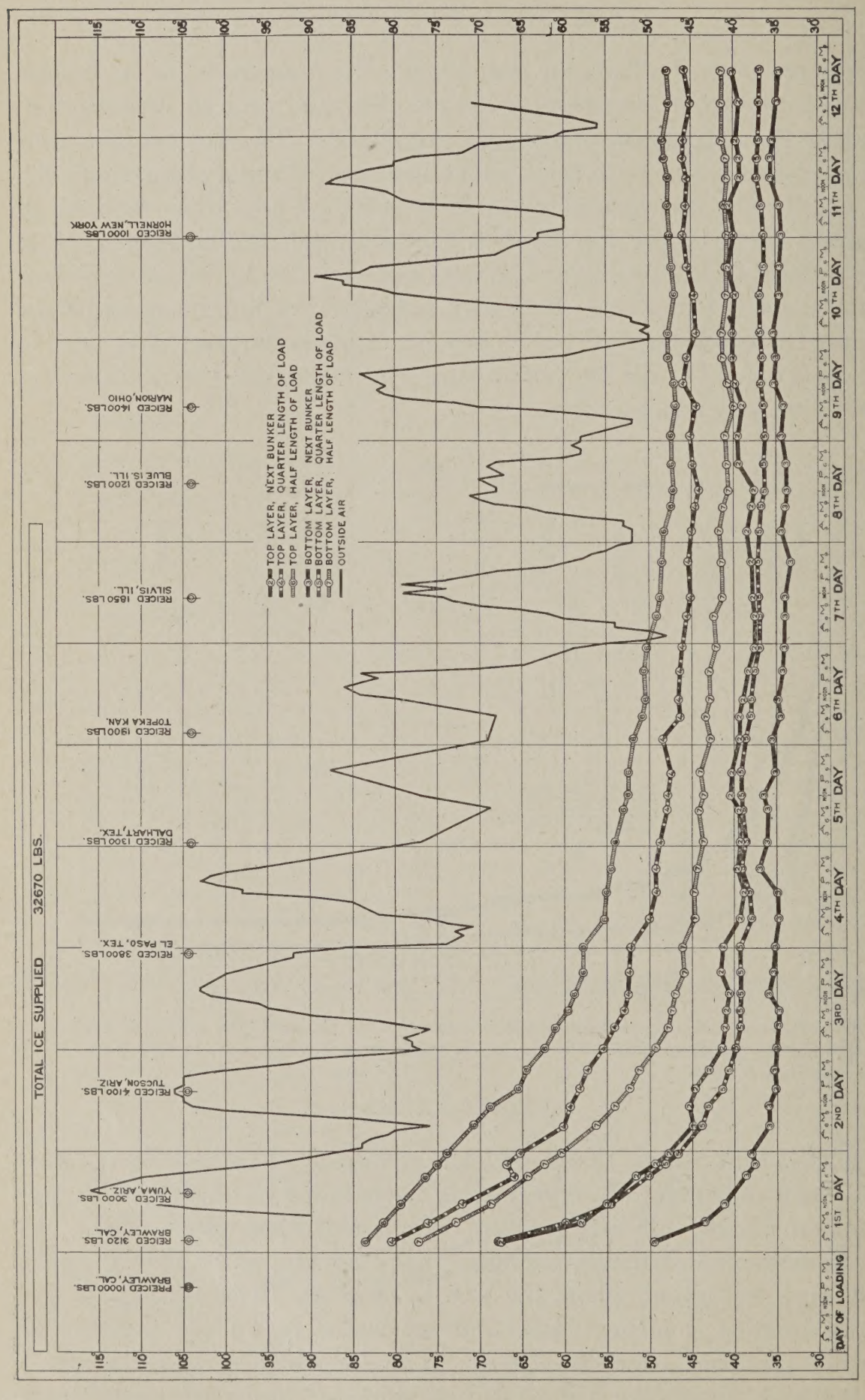


FIG. 4.—Diagram showing cantaloupe temperatures in a car similar in quantity of insulation to the car represented in figure 2, but of poorer construction and in poorer repair. This car was in transit from Brawley, Cal., to New York, N. Y., June 26 to July 8, 1917.

Figure 2 presents graphically the temperatures in an ordinary refrigerator car, loaded 7 crates wide and 3 high, shipped from Brawley, Cal., to New York City in June, 1917. Figure 3 shows the temperatures in a car equipped with solid insulated bunker bulkheads and floor racks, shipped from Brawley, Cal., to New York City at the same time. It will be noted that refrigeration is more

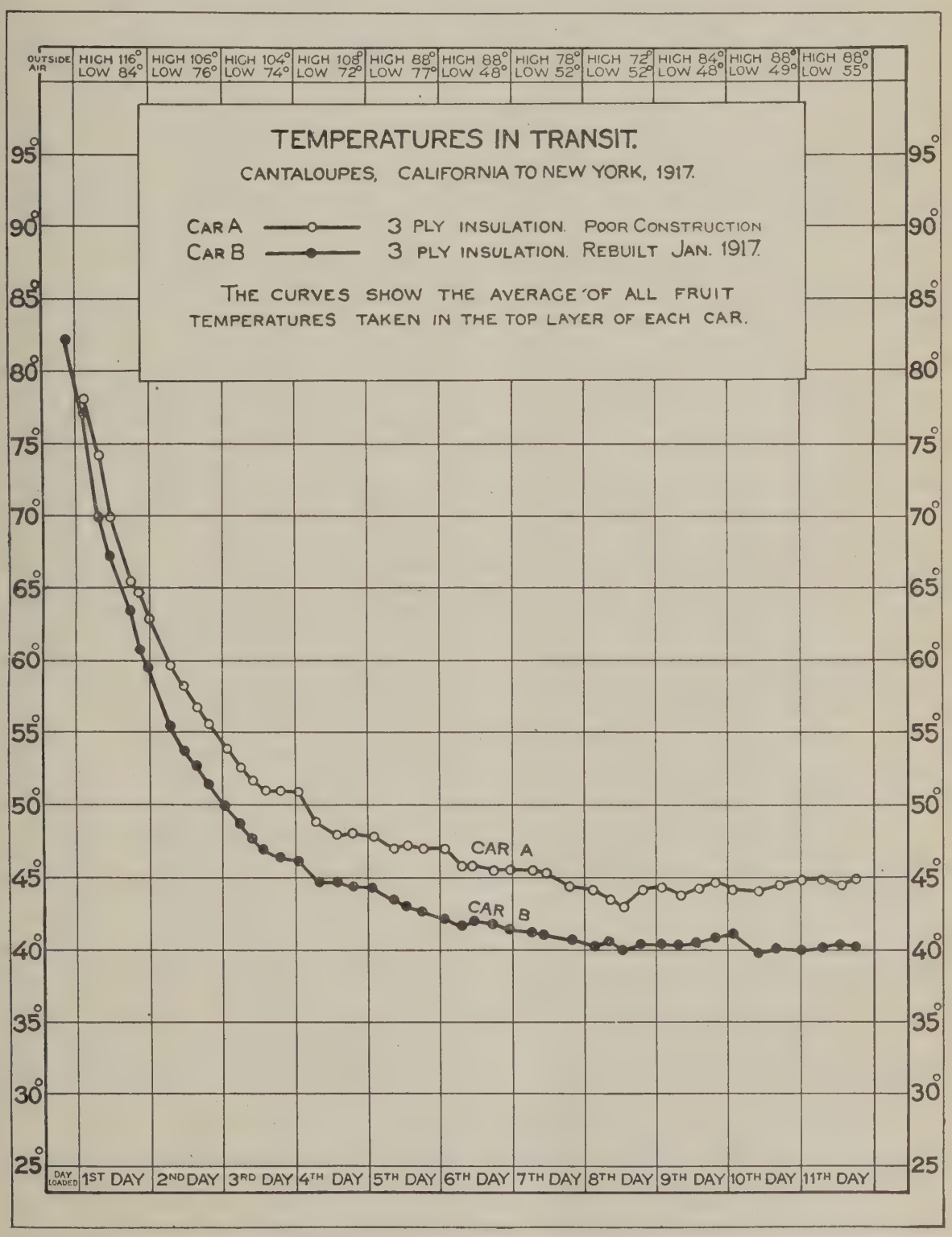


FIG. 5.—Diagram showing the average temperatures of the melons in the top layers of the two cars represented in figures 2 and 4.

uniform in the car with floor racks, and that cooling proceeds more rapidly. This is very noticeable in the temperatures of the top layer crates, especially the one located near the doorway. Other tests have demonstrated that the temperatures shown in these diagrams are representative of the conditions obtained in cars of these two types. The additional cooling obtained by the use of floor racks is an important factor in retarding ripening and deterioration. The reduction of the temperatures of the top layer is now the chief problem in transit refrigeration.

CAR CONSTRUCTION AND INSULATION

The bunker and bulkhead construction of refrigerator cars has an important effect on the refrigeration obtained in transit. In the ordinary box bunker air circulation is obstructed by the mass of ice, and refrigeration of the shipment is retarded in consequence. To overcome this difficulty, it has been found desirable to attach heavy wire screens, or perforated metal sheets, to 2-inch vertical nailing strips, which are secured to the sides and ends of the bunker. This so-called "basket bunker" provides a clear 2-inch air space on all sides of the ice. The advantages of this space are obvious.

A solid, insulated bunker bulkhead, with 12 to 14-inch openings at the top and bottom, has been found more effective than the open type of bulkhead, when used in conjunction with the wire-basket bunker and floor racks. With a bulkhead of this type, the air must pass to the bottom of the bunker and be completely chilled before it escapes to the body of the car. In cars equipped with open bulkheads, many local currents of partially-chilled air pass through the bulkheads at various points.

The ability of refrigerator cars to refrigerate cantaloupe shipments and to maintain satisfactory temperatures in transit depends, also, upon the quality and quantity of insulating material employed in their construction. Tests have shown that the minimum requirements for the floors of refrigerator cars are 2 inches of cork, protected from moisture by waterproof paper, or other waterproofing material. For the walls, 2 inches of cork, or material which is equivalent to cork in heat transmission, are necessary, and for the roof 2½ inches of insulating material, equivalent in heat transmission to 2½ inches of cork. Equally as important as the amount and quality of insulating material employed is the method of its application to the car walls, and the attention paid to details in the construction, rebuilding, or repairing of the cars.

The importance of these factors is illustrated by figure 4, which shows diagrammatically the temperatures obtained in a car of cantaloupes shipped from Brawley to New York City in June, 1917. This car may be compared with the car represented in figure 2. It contained an equal quantity of insulating material but was not of equally good construction, nor had it been as carefully inspected, or

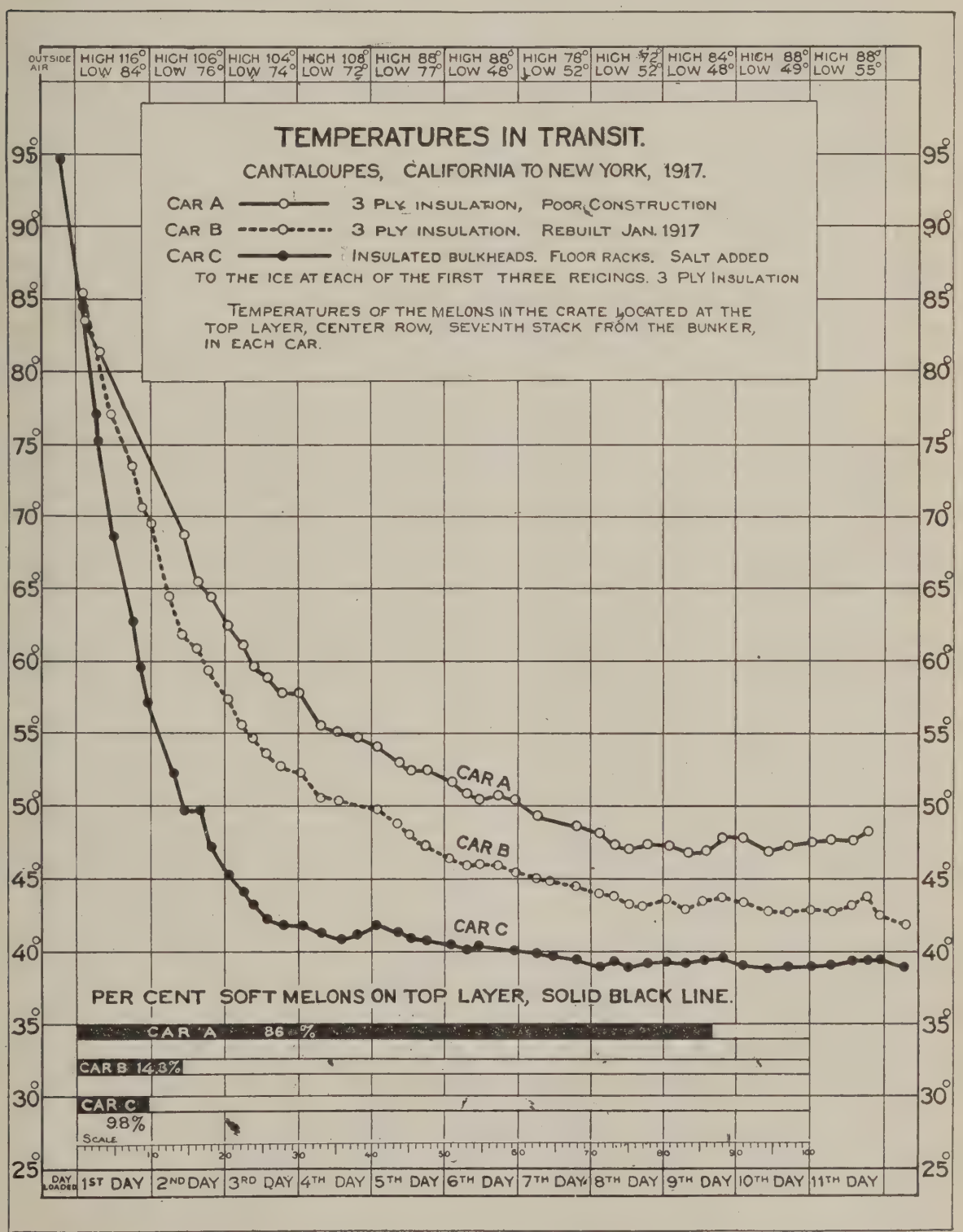


FIG. 6.—Diagram showing the warmest temperature of the melons, and the percentage of soft melons in the top layers, in the three cars represented in figures 2, 4, and 7.

repaired, when repairs were necessary. The temperature differences are striking, and illustrate the importance of close attention to details of construction and repair of refrigerator cars.

An average of the top layer temperatures in these two cars is shown in figure 5. The two upper curves in figure 6 represent the top layer temperature next to the bracing in the same cars. Attention is called to the heavy black lines in figure 6, representing the percentage of soft cantaloupes in the top layer of each of these cars when inspected at New York. Car A, it will be seen, arrived with 86 per cent soft, or all crates, except those immediately against the two bulkheads. In Car B, 14.3 per cent of the melons in the top layer were soft.

THE USE OF SALT AS AN AID TO REFRIGERATION

The refrigeration of perishable shipments is effected by the melting of ice in the bunkers of the cars. If no ice is melted no cooling results. The rather common belief that the presence of ice in itself constitutes a source of refrigeration is not correct. The actual condition is comparable to the burning of coal to produce heat. It is the coal that burns which produces heat; the mere presence of coal cannot affect temperature conditions.

After the ice is melted, the resulting cold water has very little cooling effect in comparison with that of the ice in melting. One pound of ice will take up 144 heat units during the melting process, whereas the pound of water formed from the same ice will take up only 1 heat unit for each degree which it is warmed.

Ice made from pure water melts at exactly 32° Fahrenheit. When ice is melting in contact with air, its temperature must be 32°. If it were colder it would not be melting. It cannot become warmer until after it is melted. When, however, salt is mixed with crushed ice, a mixture is formed which melts at a temperature lower than 32°. The temperature at which it melts depends on the percentage of salt and the thoroughness with which the salt is mixed with the ice. If the percentage of salt is increased, up to a certain limit, the melting temperature of the mixture is lowered. Twenty-five per cent salt and 75 per cent finely-crushed ice, thoroughly mixed, melts at about 3 or 4° below zero F. This is the lowest temperature which can be obtained with salt and ice. If still more salt is added, that is, if the mixture contains more than 25 per cent salt, the melting temperature will not be as low.

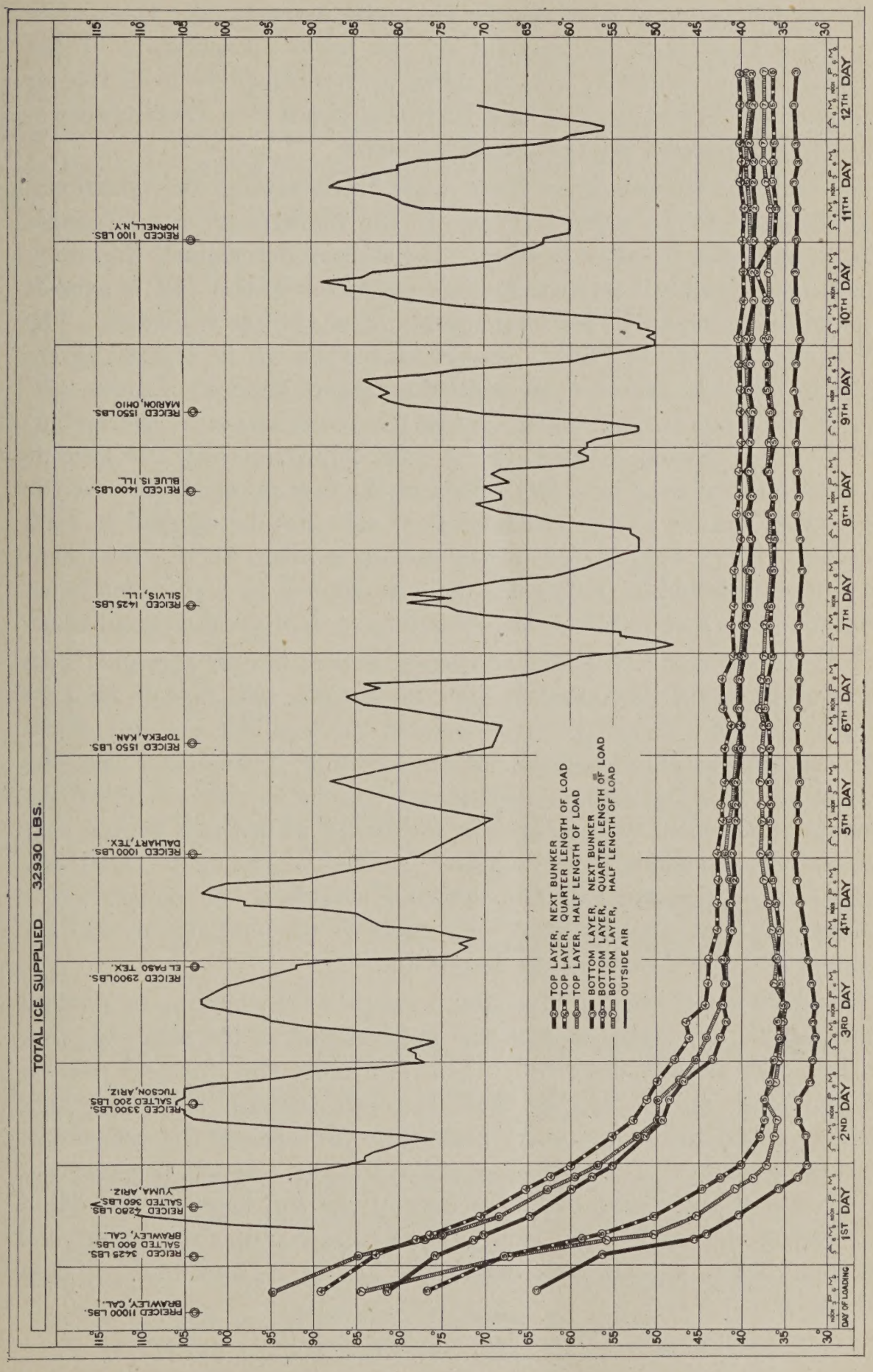


FIG. 7.—Diagram showing cantaloupe temperatures in a car equipped with basket bunkers, insulated bulkheads, and floor racks. Salt was added to the ice in this car as shown in the diagram. The car was in transit from Brawley, Cal., to New York, N. Y., June 26 to July 8, 1917.

In an ice and salt mixture, the ice melts more rapidly than when ice alone is present, on account of the lower temperature of the mixture. Consequently, heat is taken up more rapidly from the air and produce within the car, and both are cooled to a lower temperature than is possible by the use of ice alone.

Several experiments have been made to determine the additional cooling obtained by salting the ice in the bunkers of cars of cantaloupes immediately after loading. It has been determined that cooling is considerably hastened by this practice. When salt is used it should be added to the ice immediately after the car is loaded. The ice at the top of the bunker should be broken up into small pieces with an ice pick, and the salt applied on top of the ice. Coarse salt, No. 2 or larger, is preferable. When the temperature of the melons is 80° F., or higher, 10 per cent of salt, approximately 500 pounds to each bunker, may be safely added at the first application. At the first icing station 100 to 150 pounds of salt may be applied to each bunker. If the temperature of the melons is below 80° F., the quantity of salt should be reduced, not more than 5 to 8 per cent being added at the first application, according to temperature conditions.

Salt should never be added to the ice, except in cars equipped with floor racks, solid, insulated bunker bulkheads, and basket bunkers which provide a 2-inch air space around the ice. On account of the obstructions to air circulation in the ordinary refrigerator car, the use of salt in a car of this type merely serves to chill or freeze the melons at the floor of the car near the bulkhead without in any way hastening the cooling in the warmer portions of the load. With the improved construction already described, however, air circulation is continuous and unobstructed, and there is no banking of cold air against the crates close to the bulkhead.

Figure 6 shows the top layer temperature at the bracing in a salted car (Car C) as compared with the temperature in the same location in two cars already described. This is usually the warmest portion of the load, and it will be seen that refrigeration is considerably hastened and the temperature materially lowered by the use of salt and the improved construction of the salted car. It will be observed, also, that 9.8 per cent of the melons in the top layer of the salted car were considered "soft" from a marketing standpoint upon arrival at destination, as compared with 86.0 in Car A, and 14.3 per cent in Car B.

MISCELLANEOUS PRACTICES AFFECTING REFRIGERATION

The practice of opening either the front or rear ventilators of a refrigerator car during the first night the car is in transit has some adherents among cantaloupe shippers. A few tests have been made of the value of this practice, but the results obtained are inconclusive.

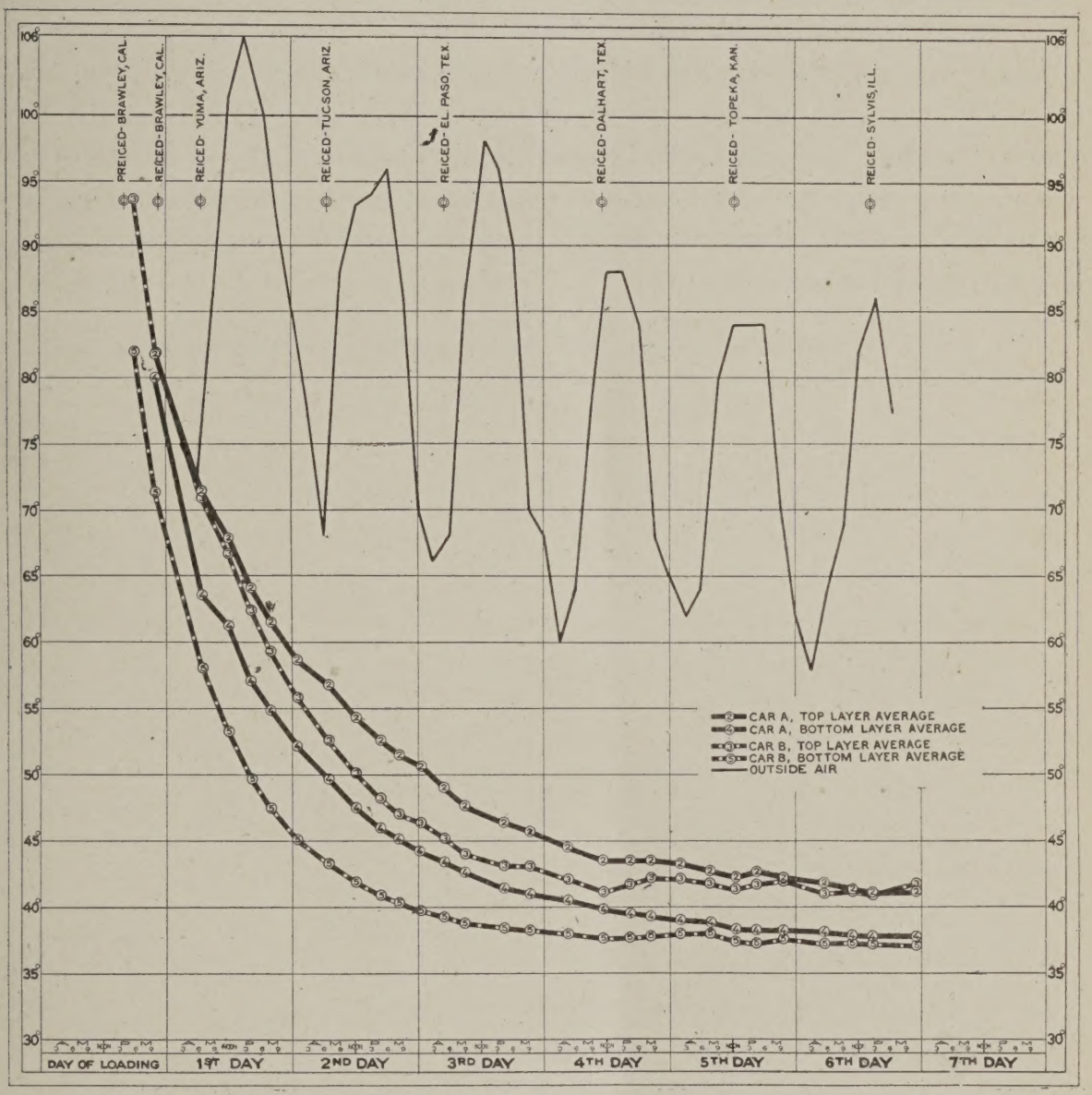


FIG. 8.—Diagram illustrating the effect of wrapping cantaloupes upon temperatures in transit. The melons in car A were wrapped; those in car B were not wrapped. These cars were in transit from Brawley, Cal., to Chicago, Ill., June 19 to 25, 1916.

It can be definitely stated that refrigeration is not hastened by this practice; on the other hand, the admission of outside air during the night does not seem to raise the cantaloupe temperatures or retard refrigeration. An average of 400 or 500 additional pounds of ice is melted in each car when the ventilators are open.

It is claimed that cantaloupes arrive at market in a firmer condition and that fewer yellow melons develop when they are shipped

in cars with the ventilators open the first night. No conclusive data have been obtained either proving or disproving this claim.

The practice of wrapping cantaloupes serves to some extent to retard refrigeration.[1] The paper fulfills the function of an insulating covering, and prevents the transmission of the field heat of the melons. In addition, the paper wraps tend to obstruct the circulation of cold air around and through the crates. This is illustrated in figure 8, which presents the average of the top and bottom layer temperatures of two cars of similar construction, loaded similarly, with the exception that the melons in one were wrapped and those in the other were not wrapped. The differences shown are representative of the retardation of refrigeration which may be expected when cantaloupes are wrapped for shipment.

[1] Fischer, G. L., and Nelson, A. E. More care is needed in handling Western cantaloupes United States Department of Agriculture, Markets Document 9, 1918.